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The HISTORY of CHROMITE MINING
in
PENNSYLVANIA and MARYLAND

by

Nancy Pearre and Allen Heyl



COMMONWEALTH of PENNSYLVANIA

DEPARTMENT of INTERNAL AFFAIRS

Genevieve Blatt, Secretary

TOPOGRAPHIC and GEOLOGIC SURVEY

Carlyle Gray, State Geologist

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FOREWORD

Pennsylvania is not only one of the nation's largest mineral-producing States today, but records such as the one presented here demonstrate a history of leading mineral production in former years as well.

Because the history of any mining locality serves not only as an account for historical archives but also as a basis for further study and understanding of the origin and distribution of the mineral deposits in the area concerned, we are proud to present this record of what was once the largest chromite-producing area in the world.

Chromite continues to be a much needed strategic mineral commodity, and we hope that this account will contribute to a better understanding of Pennsylvania's chromite potentialities.

A handwritten signature in dark ink, appearing to read "Genevieve Blatt", with a stylized flourish at the end.

Genevieve Blatt, Secretary
Department of Internal Affairs

February 1959

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THE HISTORY OF CHROMITE MINING IN
PENNSYLVANIA AND MARYLAND¹

by

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ABSTRACT

The history of rock chromite mining and placer chromite recovery in Pennsylvania and Maryland is traced from its inception, about 1810, up to the present time. Of the forty mines and prospects known, some data is available for twenty-seven of the most important. Between 250,000 and 280,000 tons of chromite were mined, in addition to about 15,000 tons of placer chromite. The ore ranged from somewhat less than 30 per cent Cr_2O_3 up to about 55 per cent. Shortly after discovery, much of the Pennsylvania and Maryland chromite was under the control of Isaac Tyson, Jr. and his sons, who continued operations until 1882 when the Wood mine closed, ending the supremacy of chromite production in eastern United States. Placer mining was continued into the early 1900's. During the two world wars, interest in the old chromite mines was revived, but no significant production resulted.

INTRODUCTION

Few residents of southeastern Pennsylvania and Maryland today are aware that the area once supported a large-scale mining industry. Chromite², the only ore of chromium, was mined there during much of the nineteenth century and supplied the raw material for a local chemical and pigment manufacturing industry that was for many years the only one of its kind in the United States. All the chromite ore produced in this country before about 1865, and a substantial part of it until after 1875, came from Pennsylvania and Maryland (fig. 1); it not only satisfied the domestic demands of the century, but was also exported to Europe in large quantities.

This history of chromite mining in Pennsylvania and Maryland has been gleaned from numerous published and unpublished sources, some of which are obscure. A more detailed account of the past production and geology of the chromite deposits is to be included in a report in preparation by the writers.

¹Publication authorized by the Director, U. S. Geological Survey.

²The mineral chromite is basically an oxide of chromium, iron, aluminum, and magnesium. Its uses are related to its composition, which varies widely within the general framework $(\text{Mg}, \text{Fe}^{II}) (\text{Cr}, \text{Al}, \text{Fe}^{III})_2\text{O}_4$. Over half of the chromite currently consumed in the United States is used by the metallurgical industry in manufacturing alloys such as stainless steels, tool steels, and high-temperature alloys. Other products are chrome refractories, used principally for lining steel furnaces, and chromium chemicals, used in pigments, metal treating, and tanning. The demand for chromite is large and increasing, and the United States produces practically none. Current U. S. sources of metallurgical chromite are Turkey, Southern Rhodesia, and New Caledonia; of refractory chromite, the Philippines and Cuba. All our chemical chromite comes from the Union of South Africa.

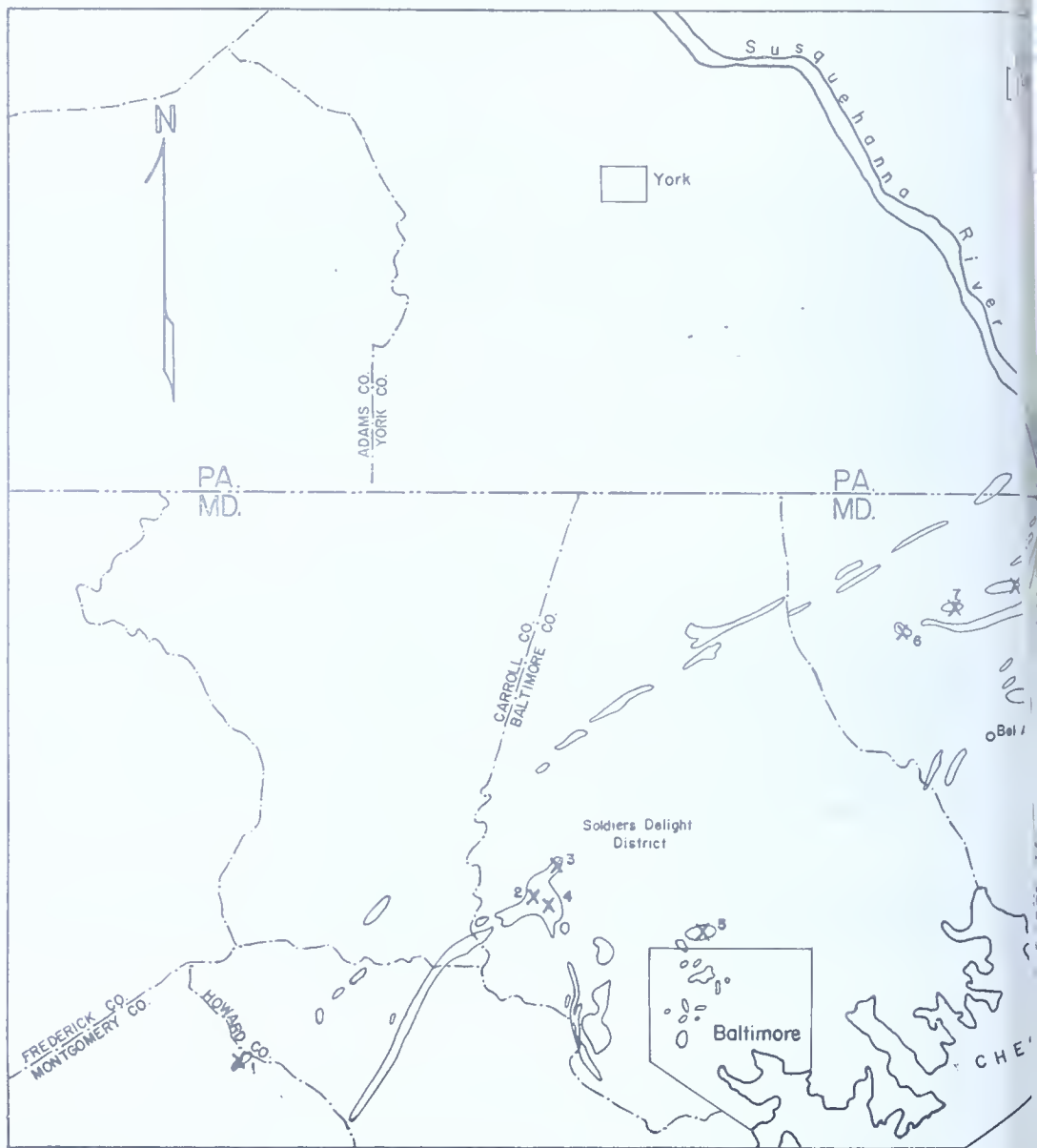
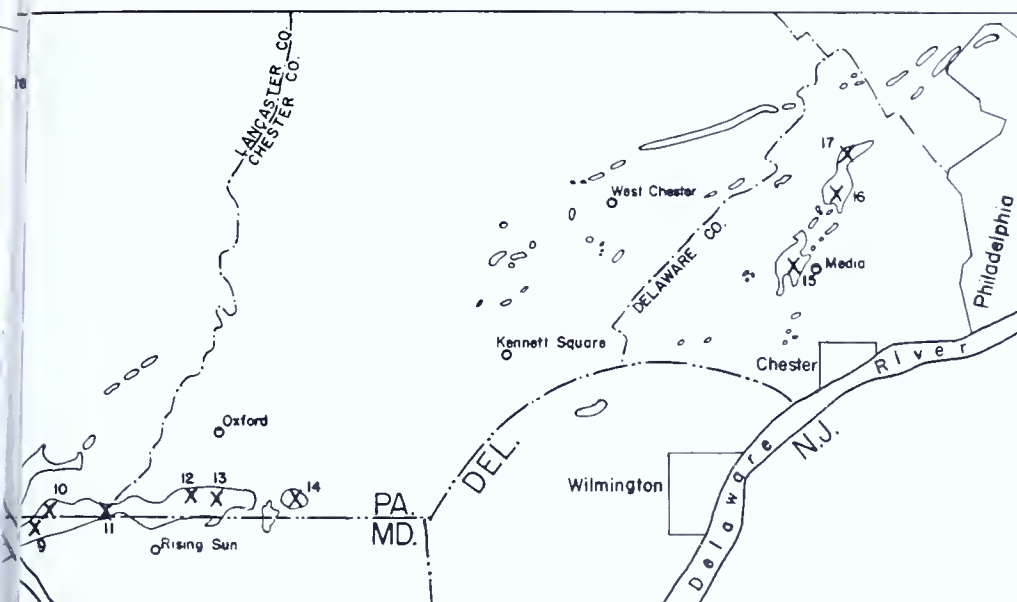


Figure 1

CHROMITE MINES IN PENN



1. Etchisan and Griffith mines
2. Harris and Weir mines
3. Calhoun mine
4. Choate mine
5. Bare Hills mines
6. Reed and Wilkins mines
7. Ayres mine
8. Cherry Hill mine
9. Line Pit mine
10. Red Pit, Wet Pit, Rock Springs, Jenkins, Reynolds and Watt mines
11. Wood, Hillside, Carter, Cactus, Dag, Cow and Texas mines
12. Scott and Kirk mines
13. Pine Grove and Hilaman mines
14. White Barrens placers and mines
15. Placers near Media
16. Moro Phillips Mine
17. Mora Phillips Mine



SERPENTINE



CHROMITE MINE(S)

0 5 10 15 20 MILES

YLVANIA AND MARYLAND

Three types of chromite ore deposits -- massive, disseminated, and placer -- were mined in the area. Massive ore (fig. 2) is a dense aggregate of pure or almo

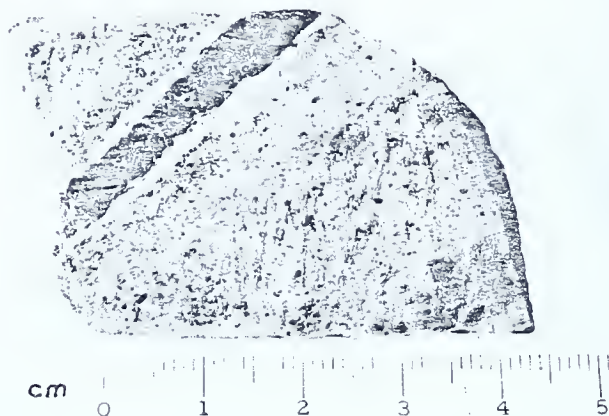


Figure 2. Vein chromite (black) in serpentine from the Wood mine.

pure chromite that occurs in veins and bodies of very irregular shapes and sizes. Disseminated or "birdseye" ore (fig. 3) consists of individual grains of chromite embedded in the enclosing rock in varying concentrations; it forms gradational boundaries between massive chromite bodies and barren rock or, more frequently, it forms separate extremely irregular bodies. Both massive ore and disseminated ore are sometimes designated "rock chromite." Placer deposits of sand and gravel containing loose crystals and grains of chromite occur in the beds and flood plains of streams that drain areas underlain by chromite-bearing rocks. As erosion of the rocks continues, many of the placers are slowly renewed. Workable deposits range from a few inches to four or five feet in thickness; they are generally overlain by a few inches to several feet of alluvium. Chromite concentrates produced from placer ore are locally called "sand chromite."

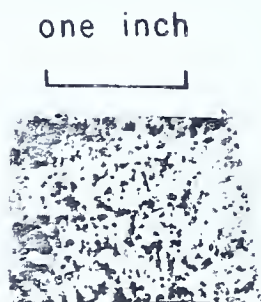


Figure 3. Disseminated chromite in serpentine from Bare Hills.

Massive ore was hand-sorted and shipped as it came from the mines, whereas disseminated ore required grinding and concentration of the chromite grains. Placer chromite sands were concentrated to a commercial grade by sieving and repeated washings in a troughlike concentrator known as a "buddle".

More than 40 abandoned rock-chromite mines and prospects are known in Pennsylvania and Maryland, and most of the streams that drain chromiferous areas were the sites of placer operations (fig. 1). Nineteenth-century production figures for these are incomplete and conflicting. Estimates from the available data indicate that the aggregate production from 27 of the 40 known mines totalled between 250,000 and 280,000 tons of massive and disseminated ore, although some reports of dubious reliability place the figure as high as 500,000 tons. (See Appendix I.) (Information is completely lacking for the other 13 mines, some of which were apparently fair-sized). In addition, placer deposits produced considerably more than 15,000 tons of concentrates. Grade of the ore and concentrates ranged from 30 to about 63 percent chromic oxide. The grade of the chromic oxide in the Wood mine area chromite analyzed during the years of peak production varied from 51.56 to 63.384 percent, the latter setting a world's record at that time (from an unpublished report by Frank Gorrecht). "Only five percent [of the ore] had to be kobbled; and the average output of the mine was ten thousand tons a year [or] eight tons a day for each of the three persons connected with the operation." Most of the chromite was used to manufacture chemical compounds, pigments, and dyes, before metallurgical and refractory uses for chromite were developed.

Exploratory work and small-scale mining in Pennsylvania and Maryland between 1908 and 1928 produced about 1,500 long tons of chromite ore and concentrates. Of this, 920 tons, ranging in grade from less than 30 percent to 54 percent chromic oxide, was sold, mostly to steel manufacturers.

CHROMITE-BEARING ROCKS

The chromite deposits occur in serpentinized ultramafic rocks. These rocks, of igneous origin, were originally composed principally of one or more of the common magnesium-iron silicate minerals (olivine, pyroxene, and less commonly amphibole) but have been partly or completely altered to serpentine and talc. Geologists have found "serpentine" a convenient general term for this group of rocks collectively.

The geologic relations of the chromite in the early mines of Pennsylvania and Maryland is poorly known. Concerning the Wood mine, Frank Gorrecht reports that data obtained by Colonel Glenn revealed that "the ore bodies on the upper levels ran east and west, and on the lower depths, north and south; that the main body, running south slightly east, was ten feet thick and averaged thirty feet in width.

The ore at the Line Pit was massive and encased by williamsite, -an emerald green serpentine often used as a semi-precious gemstone (fig. 4).

According to Gorrecht the only outcrop of chromite ore in the region was across the Octararo Creek from the Wood mine. A trench was dug and some high-grade chromite removed (loc. 11, Hillside).

Areas underlain by serpentine have a physical appearance that contrasts markedly with the fertile farmland underlain by schist nearby. Locally termed "serpentine barrens", such areas are wild, desolate, and uncultivated. In places they support practically no vegetation except sparse grasses and are truly "barren"; elsewhere scrub pine and cedars thrive, and greenbrier grows in such profusion that penetration on foot is difficult if not impossible. The wildness of these barrens was vividly described in an early scientific description of the Bare Hills north of Baltimore, Maryland (fig. 1, loc. 5). The barrens have changed little, and they appear today as they appeared in 1814 when H. H. Hayden wrote (1814, p. 244):

"The mind seems involuntarily to feel the impulse of melancholy. A gloomy silence pervades around, while every road on the serpentine range bears the most decided marks of sterility. If a fratricidal Cain had here committed his Heaven-insulting deed, we need no wonder; it bears so much the appearance of having experienced the unappeased wrath, the eternal curse of an offended Deity."

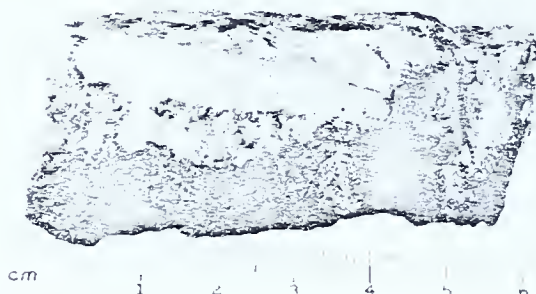


Figure 4. Massive chromite from Line Pit. In contact with sheath of translucent green williamsite.

EARLY MINING AND MANUFACTURING

The same barrens that produced Hayden's "impulse of melancholy" were the place where chromite was first identified in the United States. In 1808 or 1810 chromite was found on or near the estate of Jesse Tyson at Bare Hills by an Englishman named Henfrey, who had worked in a chemical plant where chrome pigments were manufactured. Henfrey recognized it and brought it to the attention of Tyson's son, Isaac Tyson, Jr.³, a former apothecary's apprentice with a keen interest in chemistry.

The Bare Hills deposit was mined before 1811, possibly by Isaac Tyson, Jr., to supply a Philadelphia paintfactory (anonymous, 1811). In 1811 another chromite deposit was discovered in Chester County, Pa., by a gentleman identified only as Mr. Smith, and by 1818 two deposits in Pennsylvania (fig. 1, probably nos. 16 and 17) were supplying chromite for use "in the arts". In (Lea, 1818) 1822, when local chromite ore was valued at \$40-60 a ton, rock chromite in place and loose boulders of massive chromite were known to occur in Harford County, Md., and both rock and placer deposits were reported in the Soldiers Delight area in Baltimore County, Maryland (Cleaveland, 1822).

Between 1810 and 1822 the chromite mined in Pennsylvania and Maryland was manufactured into yellow paint, at first in Philadelphia and later in Baltimore. Bare Hills chromite was used before 1811 by the plant of Godon and Peale, who sold the paint made from it to Philadelphia chair and sign painters for \$2 an ounce. After 1811 W. Hembell supplanted Godon and Peale in using local chromite ores (anonymous, 1811). In 1819 about 3,000 pounds of chromate of lead, or "chromic yellow", was manufactured in Philadelphia (Cleaveland, 1822) and within the next four years a plant in Baltimore also began to produce chromic yellow.

³Isaac Tyson, Jr., was the son of Jesse Tyson. The "Jr." has been dropped from his name in most of this paper for convenience.

The fate of these small paint factories after 1822 is not definitely known, but later references suggest that for many years they continued to process small quantities of local chromite. The greatest demand for chromite after 1822, however, was in Europe, where the market was greatly enlarged by the introduction of chromium salts into dyeing processes.

ISAAC TYSON'S MINING INDUSTRY

The development of chromite mining in Pennsylvania and Maryland into a large and important industry was due largely to Isaac Tyson, Jr. He began to acquire mining rights at Bare Hills in 1817 or earlier and may even have been responsible for mining there from the beginning. Before 1825 he also began to lease mining rights in the Soldiers Delight area, the first production from which was apparently placer chromite.

In 1827, when chromite was worth \$100 a ton in foreign markets, the fortuitous discovery of a large rich deposit of chromite in Maryland started a rapid expansion of the Tyson interests. In that year Isaac Tyson recognized as chromite some heavy black boulders supporting a cider barrel in a farmer's cart in Belaire market, Baltimore (Glenn, 1896, p. 487). He found that they came from the Reed farm in Harford County (loc. 6), where nearly 30 tons of chromite boulders lay on the surface. Tyson promptly leased the farm and began to work the first large high-grade massive chromite deposit ever discovered. The surface ore was carted to Baltimore, barrelled, and shipped to Glasgow, Scotland. A shaft sunk on the discovery spot penetrated rich chromite ore in place at a depth of eight feet, and the Reed mine proved so profitable that other operations were soon suspended. Despite a period in the middle of the century when it, too, was closed in favor of the more profitable mines in the State Line district, it remained the largest producer of chromite in Maryland.

Tyson continued his exploration for chromite, locating other serpentine areas and purchasing or leasing property wherever indications were favorable. Not long after the Reed mine was opened, he discovered chromite deposits on both sides of the Mason-Dixon line and began to develop the State Line district. His Wood mine (loc. 11), opened in 1828, for a while supplied most of the world's chromite and ultimately proved to be the most productive high-grade chromite mine that has been worked in the United States to date.

For some years after these discoveries both rock and placer deposits were developed rapidly under the stimulus of high market prices both at home and abroad. In 1833, \$56,000-worth of pigment and dye products were manufactured domestically from Pennsylvania and Maryland chrome ores, most of which (\$45,000-worth) was exported (Ducatel⁴, 1834). Only a part of the chromite that was mined went to domestic manufacturers, for until 1845 Tyson exported most of his raw ore and concentrates to European markets for processing. Between 1828 and 1850 the world's supply of chromium came almost entirely from Pennsylvania and Maryland. The main Tyson mines during this most productive period were the Wood, Reed, Red Pit (loc. 10), Scott (loc. 12), and Hillside (loc. 11) mines, the mines at Soldiers Delight, and possibly the Carter mine.

Tyson developed a near monopoly of chromite mining in the two states before 1850, but he was not alone in the business. Some small mines were operated by other individuals or started by others and then acquired by Tyson, and many of the placers were worked during slack seasons by the farmers who owned the land. However, most of the ore produced by others was sold to or marketed through Tyson.

Some of the mines that were not started by Tyson, such as the Scott (probably loc. 12) and Line Pit (loc. 9) mines, became the objects of lawsuits concerning mining rights. The Scott mine was opened in 1834 by William Scott. The following year, for

⁴ Ducatel discusses other Maryland chromite mines in his reports for 1838 and 1839.

a cash payment of \$1,000, Scott granted Tyson a lease covering the "vein" Scott had started to work but carefully restricting Tyson's work to this particular "vein". Scott is reported to have then opened another mine nearby that drained into Tyson's mine. When Tyson lost the resulting litigation, he closed his mine. Although worked for only a short period of time, the Scott mine is reported to have produced between 3,000 and 6,000 tons of ore and to have reached a depth of more than 200 feet.

The Line Pit deposit (loc. 9) was the subject of much litigation because it is crossed by the Mason-Dixon line. The deposit was discovered north of the line, in Pennsylvania, on the property of Andrew Lowe, and was mined for a while under lease by William Scott and Joshua Lowe, who transferred their rights to Tyson in 1838. Legal difficulties resulted in a new lease, which granted Tyson exclusive mineral rights until 1841. The Line Pit ore body was found to plunge southward into Maryland and other legal problems reportedly developed. By 1844 Tyson had lost the mining rights again; he was then buying the Line Pit ore from Benjamin Gibson and Joshua Lowe for \$23.50 a long ton. Finally, in 1856, Tyson purchased the property on the Pennsylvania side from Andrew Lowe.

Not much information has survived about the extent and success of Tyson's activities in some of the other chromite-bearing areas. This is particularly true of the White Barrens (loc. 14), where between 1835 and 1838 he acquired leases permitting him to dig for chromite on a large number of properties. Some were perpetual leases and were retained by his heirs after his death; others were short-term leases which Tyson soon allowed to expire. At least one property in the White Barrens, that of Reub. Harris, seems to have been exploited before Tyson leased it, inasmuch as the lease reserves for Harris the diggings made by W. T. Harris. Another appeared promising to Tyson (1828-1849), for he wrote across a sketch of the area that there was "plenty of chrome about the diggings" on the William Cullum property. The "diggings" on both properties could have been for placer chromite or for rock ore. Both types of deposits were worked in the White Barrens, but the literature indicates that the placers were more valuable than the rock deposits.

About 1835 the Maryland State Geologist Joseph Ducatel announced the occurrence of chromiferous serpentine in Montgomery County, and in the next five years Tyson acquired perpetual mineral rights on ten or more favorable properties there. In so doing he seems to have antagonized Ducatel (1938, p. 30-31, 33):

"The occurrence of the ore in this region was announced by me a few years back, which led to its extraction in several localities. Contracts were entered into without a proper knowledge, on the part of the owners of the lands, of the value of the material which they contained, and exclusive privileges were granted to make researches and excavations, under terms that, besides securing nearly all the benefits to one only of the contracting parties, prevented a full development of the resource to the county.... The cupidity of some dealers will often prompt them to.... solicit contracts, always for a trifling consideration, for the exclusive privilege of mining, where they have no intention of using it; as the sole object is to keep out of the market that of which they would endeavor to monopolize the sale...."

Ducatel named chromite as the "principal mineral resource" of Montgomery County and reported that from the time of its discovery in the County until 1837, hundreds of tons were mined from several localities and ore was indicated at many others. However, most of Tyson's Montgomery County leases are marked "of no account" or "of no avail" in his record book (1828-1849); and much of the ore was apparently too low grade to merit the development Ducatel expected for it.

JESSE TYSON AND COMPANY

Isaac Tyson realized that his near monopoly of chromite production could not be maintained indefinitely. Anticipating that further discoveries might flood the British market with chromite, he attempted to establish a factory for the treatment of his ores and thus to assure himself a market (Day, 1885). His first venture into paint manufacturing in 1833 proved unsuccessful, but improvements were later made in the process for decomposing chromite, and Tyson was able to use these improvements to advantage. In 1845 he and his son Jesse as equal partners established the firm of Jesse Tyson and Company in Baltimore, which virtually monopolized the manufacture of chromium compounds in the United States for more than forty years. The following year they made manufacturing history by hiring W. P. Blake of Yale College as the first chemist employed in technology in the United States. Blake later became one of the best known economic geologists of the nineteenth century.

The Tyson plant was the most important and successful, but apparently not the only chrome works in this country around 1850. Dieffenbach (1855, p. 535), who worked in the Tyson factory prior to 1855, records that some Pennsylvania chromite was being used in a chrome works in Philadelphia as well. Presumably, therefore, one of the small paint factories operated earlier in the century had either remained in existence or been reopened.

LATER YEARS OF MINING

In spite of the newly established home market, the discovery in 1848 of large chromite deposits in Turkish Asia Minor marked the beginning of a decline in chrome mining in Pennsylvania and Maryland. By 1860 exports from this country had practically ceased because Turkish chromite was supplying the European market. The death of Isaac Tyson in 1861, the Civil War, and probably also the exhaustion of near-surface ore, combined to halt operations temporarily at many of the mines.

Tyson died a wealthy man and his chromite holdings passed on to his sons, who in 1867 incorporated the Tyson Mining Company and the Baltimore Chrome Works to continue their father's mining and manufacturing businesses. In 1868, however, the newly formed mining company suffered the loss of its two largest mines. The Wood mine, which had remained a steady producer, was flooded because pumping facilities were inadequate, and the Red Pit mine (loc. 10), operated to a depth of 500 feet and said to have been almost as large a producer as the Wood mine, was suddenly permanently closed by an unexplained explosion on the 400-foot level. Reports of an embezzlement suit against the superintendent shortly before the explosion lend an air of intrigue to the history of the Red Pit mine, and knowledge of the mine was virtually lost after 1868.

In the late 1860's and early 1870's the Tyson Mining Company, deprived of its two major sources of chromite, renewed operations at most of its Maryland deposits, particularly in the Soldiers Delight district and at the Reed mine. During this period other operators were also able to mine chromite profitably on a small scale. The Ayers mine (loc. 7) was worked; Frank Rigdon produced concentrates from a placer at Cherry Hill (loc. 8); and Wilkins and Streett produced disseminated and massive chromite from the Wilkins mine (loc. 6). Disseminated ore from the Wilkins mine was concentrated in the nearby Wetherill mill, which had been built in 1857 as a grist mill. The Wetherill mill was still standing in 1956, and in it were old sacks labelled "Chrome Valley Flour," recalling its connection with the mining industry of a bygone century.

The Pine Grove property in Pennsylvania (loc. 13), acquired by Tyson in 1839 but possibly not mined by him, was owned and mined by Moro Phillips of Philadelphia in the late 1860's and early 1870's. E. Mortimer Bye of Wilmington, Del., was his mining superintendent. In 1872 new pumps were installed at the main shaft to cope with serious water problems; mining continued into the following year but ceased before the summer of 1874. In 1874 Bye produced chromite from a nearby placer deposit on Black Run.

A chromite deposit east of the Pine Grove mines was discovered in 1873 by J. Smith Hilaman while he was repairing the road on his property. Early in 1874 local newspapers reported that development work had proved the deposit to be large and the ore a good grade; however, mining operations were neither extensive nor long-lived.

In 1873 the Tyson Mining Company reopened the Wood mine by unwatering it to the foot level on an angle of 45 degrees (F. Gorrecht), sealing off the lower levels with a wooden platform, and mining lean ore that remained in the walls of the upper workings. During the next few years they also mined extensively at the Reed mine, shipping the massive ore as mined and concentrating the disseminated ore in the Wetherill mill. The mill, which was then operated by Carroll Pennington, was equipped with twelve stamps for crushing the ore, circular buddles for preliminary concentration, and troughs for final concentration; it had a capacity of one tone of concentrates per day (Singewald, 1928, p. 183).

CLOSING OF THE MINES

In the early 1860's, chromite deposits had been discovered in California by a representative of the Tyson interests (Day, 1885, p. 569-570). The Tyson Mining Company apparently started mining the California deposits as early as 1869, and by 1874 competition from California chromite in the eastern United States was keen. Valued at \$18-20 per long ton in San Francisco, the ore was shipped as ballast by way of Cape Horn to Baltimore, where its value was \$35-40 a long ton.

As more and more deposits were discovered and developed in the West, the Tyson Mining Company began closing its eastern mines. A variety of immediate reasons have been cited (Day, 1885, p. 571; Knopf, 1922, p. 87) for the closing of individual mines, including exhaustion of ore, depth of mining, inadequate pumping facilities, litigation over mining rights, and decline in price. Late in 1874 the Line Pit mine was closed because chromite was no longer being obtained in paying quantity, and in 1877 the staff of the Wood mine was considerably reduced. The Choate mine (loc. 4) was closed about 1880 although it was reportedly producing high-grade ore; the immediate reason for closing is said to have been a disagreement between one of the Tysons and a business partner. Also about 1880 the Calhoun mine (loc. 3) and the Reed mine were closed. The Tysons kept the Wood mine open until 1882 as a reserve against possible failure of shipments from California.

From about 1877 until 1895 the Tyson Mining Company was beset with troubles, according to records of the Maryland Court of Appeals⁵. Isaac Tyson had regulated the prices paid by the chrome works for his eastern ores, but after his death the prices were determined less favorably for the Tyson Mining Company by the Baltimore Chrome Works, which could and did buy ores from other producers in California and from foreign countries. Between 1877 and 1880 this situation developed into a serious controversy; it finally led to arbitration that in 1880 was settled in favor of the mining company. By this time most of the eastern mines were closed. After 1881 the funds of the Tyson Mining Company were reportedly mismanaged in speculative ventures⁵. Many of its eastern properties were sold during the 1880's and 1890's, the company in each case reserving the right to mine and remove chrome ore. During these years the properties in Pennsylvania that included the northern part of the Line Pit mine, the Red Pit mine, and several deposits of disseminated chromite, were purchased by J. A. Peoples and subsequently became known as the "Peoples tract" (loc. 10).

During the 1870's numerous short-lived attempts were made in Philadelphia, New York, and Boston to establish plants that could compete with the Baltimore Chrome Works in decomposing chrome ore and manufacturing chromium compounds (Day, 1885, p. 568). About 1880 Harrison Brothers began to manufacture small amounts of chromium

⁵Reports of cases argued and adjudged in the Court of Appeals of Maryland, W. H. Perkins, Jr., State Reporter, v. 121, p. 597-607 (1913); Records and briefs, Oct. term 1913, Record no. 15 (filed June 13, 1913).

salts successfully at their Kalion Works in Philadelphia, using California ore, but the Baltimore Chrome Works maintained its importance. In 1902 the Tysons sold it and retired from the chrome business. The plant is now owned and operated by the Mutual Chemical Division of Allied Chemical and Dye Co-p., which obtains all its chromite from foreign ores.

About 1880, when most of the Tysons' eastern mines had been closed, the Lake Chrome and mineral Company of Baltimore County equipped the old Bare Hills mines, which they had acquired in 1865, with new steam pumps and other machinery and were reportedly producing "a considerable quantity" of high-grade ore from two lode deposits and a placer. During the year 1880 the Lake Company produced 100 tons of chromite; there is no record, however, that production continued into later years.

CONTINUED PLACER PRODUCTION

After all the bedrock mines were closed, production of placer chromite was continued intermittently in the State Line and Soldiers Delight districts, mostly by local farmers. Mortimer Bye resumed placer production in the White Barrens (loc. 14) in 1881 and elsewhere in the State Line district in 1885; he shipped his product, along with placer chromite he bought from others in the district, to Liverpool. In 1894 the press⁶ dubbed Bye the "chrome king of Chester County." Other men who produced placer chromite in the State Line district included Mansell Tweed (1897 to 1899), Howard Brown (about 1898), and Joseph P. Cain (1890's and early 1900's).

For a number of years placer chromite from the Soldiers Delight district had a small demand in Europe, as it was particularly suitable for setting colors on porcelain ware and so commanded a higher price than other chromites. Placers in the district were worked by R. A. Triplett (1880-1917), who had worked for the Tysons as a boy, Jay Gore (1912-1915), and William Rose (1914-1916). About 1907 F. A. Dolfield, grandson of a former buddle operator in the district, formed the Soldiers Delight Company to produce placer chromite on his property. Principal domestic purchasers of the Soldiers Delight concentrates were W. C. Lowndes in Baltimore and Pusey Bye in Philadelphia.

MINING AND ATTEMPTS TO MINE SINCE 1900

Interest in the rock chromite mines has been shown repeatedly since 1900, particularly during World War I.

"How acute the Chrome situation was at that time may be illustrated by the fact that, up to that period, chrome was selling at fourteen (\$14.00) dollars per ton. To prevent the price soaring to prohibitive figures, it was agreed that the price of chrome should be fixed on the basis of thirty-eight percent chrome-oxide on the basis of \$1.50 a unit; that is, thirty-eight times \$1.50 or \$57.00 per ton. Five cents were deducted for each unit under thirty-eight percent. Therefore, taking thirty percent chrome as a basis, the eight units at five cents a unit would be forty cents, reducing the price to \$1.10 per unit or thirty times \$1.10 is \$33.00 per ton. For every unit above thirty-eight percent, two and a half (2 1/2¢) cents were added so that, taking a fifty percent chrome, we have twelve additional units or thirty cents added to the \$1.50, making it \$1.80 a unit or \$90.00 a ton for the chrome."

About 1915 the Texas Mining and Manufacturing Company of New York produced about forty tons of chromite ore at the Carter mine (loc. 11), probably from the old dump, then allowed its rights to lapse because of the low price of ore and scarcity of labor (Knopf, 1922).

⁶Coatesville Weekly Times (April 7, 1894). This and other contemporary newspaper clippings pertaining to the later years of chromite mining in Pennsylvania are on file at the Chester County Historical Society, West Chester, Pa.

In 1917 J. H. Buxton, Jr., obtained mining rights to the Choate mine at Soldiers Delight and, advised by two of the Tysons' old miners, he unwatered, cleared, and retimbered it, sorting out some marketable ore in the process. Early in 1918 the Maryland Chrome Corporation was organized with F. A. Dolfield as president and Buxton as general manager. The company sold 50 tons of ore from the Choate mine to a steel company; however, during the summer of 1918 the ore in sight in the mine proved too lean to ship without concentration, and work was stopped. A consultant from the Dorr Company of New York advised Buxton and Dolfield to build a plant and install a crusher, but the end of World War I and a concomitant loss of the chromite market put an end to the Maryland Chrome Corporation before any such work could be undertaken. Reported mismanagement, lack of funds, and cancellation of contracts contributed to the company's end⁷.

The State Line district, where as many as twenty-four mines had been worked was also a scene of renewed chromite mining during World War I. In 1918 the property and mining rights of the former Tyson Mining Company, which had reportedly been obtained in 1904 by the Pennsylvania Waterpower Company in connection with hydroelectric developments on the Susquehanna River, were leased by F. Lynwood Garrison's Chrom Mining Company of Philadelphia. Garrison unwatered the Line Pit mine, sank twenty feet below the bottom of the old shaft, located a lens of massive chromite, and shipped a small quantity of high-grade ore. He also planned to mill disseminated chromite that had been discarded on the dumps of several other mines on the Peoples tract (loc. 10), but his concentrating plant never materialized. Garrison was an experienced mining engineer and is reported to have had adequate backing and a sound basis for the work he did, but even his Chrome Mining Company did not long survive the sudden price drop and loss of a market that the armistice brought.

Garrison's company was active principally in Lancaster County. Farther east in the district, principally in Chester County, the National Minerals Company was active at the same time. The company was operated by Henry S. Pyle, a grandnephew of Mortimer Bye, and Craig Adair of Wilmington, Delaware. Six localities were prospected and developed to some extent, including the Wood, Hillside, Scott, and Kirk mines (loc. 11, 12). Shafts of the Tyson Mining Company were cleaned or partly cleaned and reopened, several new shafts were sunk, and numerous placer deposits were investigated. A little ore, mostly obtained by reworking old dumps, was shipped before the armistice. Reserves of placer chromite were blocked out at one of the placers and 15 tons of concentrates were shipped from it.

During the war another company built a mill on Black Run (near loc. 12) to process placer deposits, but work was still in the experimental stage when the war ended. Other companies leased or attempted to lease some of the remaining chromite properties but produced no ore.

The Reed mine, one of the three largest chromite producers in the United States when the eastern mines were most active, seems to have escaped attention during World War I but was reopened in 1922 by the Maryland Chromite Company. The mine was partly unwatered and cleaned of debris, and in 1923 the company reported that it had located nine ore pockets near the Reed mine by diamond drilling. Probably some or all of the production that continued intermittently until 1928 was from these new deposits.

Between 1932 and 1937 U. S. Bureau of Mines geophysicists cooperated with the Bethlehem Steel Company in a geophysical prospecting program for chromite in Pennsylvania and Maryland. A magnetic survey of most of the State Line district was followed by electrical resistivity surveys near the Wood mine and one of the Pine Grove (Moro Phillips) mines. In 1937 anomalies at the Pine Grove mine were drilled but no ore was found. During the same period Bethlehem Steel geologists did some magnetic work in the Soldiers Delight district in Harford County, Maryland. In 1935 another mining company is reported to have also conducted a geophysical survey in the Soldiers Delight

⁷Information on mining activities during World War I was obtained from records of the War Minerals Relief Commission, on file at the U. S. National Archives.

district and to have drilled anomalies near the Harris and Weir mines (loc. 2) without finding ore.

In 1937 the American Chrome Corporation was organized, with W. F. Gorrecht as president and J. Farrell Garvey as secretary (Ostrander, et al, 1946, p. 23-24). The corporation obtained some of the mining rights held by Garrison in 1918 and in January 1938 reported activity in Lancaster and Chester Counties. They unwatered the Wood mine but pulled the pumps in March without producing any ore.

Geophysical work was again done in the State Line district during World War II and many of the properties were re-examined, but no chromite was produced. In 1941 the U. S. Geological Survey, in cooperation with the U. S. Bureau of Mines and Hans Lundberg, Ltd., conducted an experimental magnetometer and gravimeter survey in the vicinity of the Wood mine. High gravity anomalies east of the mine that coincided with magnetic conditions favorable for chromite were drilled and considerable trenching was done by the Bureau of Mines (McIntosh and Mosier, 1948). Results were negative but are now generally considered inconclusive.

In 1941 the Kirk mine (loc. 12) was unwatered by J. A. Wilson and about 300 tons of rock and debris was removed. Some chromite ore was mined but apparently left on the dumps. B. C. Warnick and Co. of Wilmington is also reported to have unwatered the "Kirk mine" at this time and found the ore too low grade to work. It is not clear whether these two operations were at the same mine or two different mines. The U. S. Bureau of Mines examined Wilson's mine as well as many other mines and placers in both States but found insufficient ore to justify further work unless the shortage became more acute.

In 1944 and 1945 the vicinity of the Scott and Kirk mines was again investigated and the locations of old chromite mines and prospect pits were mapped in an attempt to find trends and favorable places for mining operations. Signs of bulldozing at the Scott mine indicate that some exploratory work was done at this time, but no ore was mined. No further attempts to revive the chromite-mining industry in Pennsylvania and Maryland are known to date.

APPENDIX I

The additional data presented here has been extracted by the Pennsylvania Geological Survey from an unpublished report by Frank W. Gorrecht. Mr. Gorrecht's report was kindly loaned to the Pennsylvania Geological Survey by Mr. Burtner, Burtner Coal Company, Philadelphia. A copy of Mr. Gorrecht's report is an open file at the Survey's offices in Harrisburg.

Rock Springs Pit: This mine was located one-half mile northeast of the Red Pit near Rock Springs, Pennsylvania. It was first opened about 1860, had a depth of 240 feet, and produced about 3000 tons of chromite ore. The ore was both massive and disseminated. The mine was closed as a result of competition from California chromite ores.

Tyson-Reynolds Mine: This mine was situated in a line between the Woods mine and the Rock Springs mine. It was 200 feet deep with drifts of 300 feet. This was the only State Line deposit for which the chromite was listed as "Blue Chrome Ore". It was claimed by the Tysons that this chromite contained less iron than any of the other of their deposits.

Little Horseshoe: This 'mine' was located on Pennsylvania Railroad Company property. It was not over twenty feet deep and had produced fifty tons of ore when closed because of the Tyson interests in California. This pit may be the one sometimes referred to as the "Road Pit" (Allen Heyl, personal communication).

The following tables are comparisons of estimated tonnages compiled from this report, and Gorrecht's report.

Chromite Placer Production in Tons

<u>Location</u>	<u>Original Source</u>
Chester County: 20,000	Genth
Red, Line and Wet Pits: 1,000	Tyson
White Barrens: 3,000	Gorrecht
Pine Run: 1,000	Gorrecht
Rock Springs: 1,000	Gorrecht
Elk River, 2nd: 1,500	Gorrecht
Total: 15,000	Pearre and Heyl

Chromite Mine and Pit Production in Tons

<u>Location</u>	<u>Pearre and Heyl</u>	<u>Genth</u>	<u>Eyerman</u>	<u>Gorrecht</u>	<u>Glenn</u>	<u>Bye</u>
Amos Pugh				20		
Baileys				30		
Hilamans				50		
Hillside				15,000		"large"
Little Horseshoe				50		
Lowe and Line Pit	5,000-10,000			1,500		
Melrath				50		
Moro-Phillips				250		
Red Pit				150,000		"large"
Rock Springs				3,000		
Scott	3,000-6,000			5,000		
Texas				400		
Tyson-Reynolds				3,000		
Wet Pit				"small"		
White Barrens				150		
Wood: 1868						175,000
: 1878		125,000			95,000	
: Total			200,000	200,000		225,000
Total	<400,000			412,000		

The following tabulation of sand chrome analyses is taken from notes made F. Lynwood Garrison. Exact location of the sample holes is not known. The following property boundaries are on open file at the Pennsylvania Geological Survey.

Tanley Grier property
 West property
 Rainor farm
 Cullum tract

TANLEY GRIER - Adjoining the Cullum:

Section where it joins the above is not over 90 feet wide. At the 900 foot cross section widens out to 110 feet. At the 1,000 it is about the same. The width increases at the 200 foot to about 250 to 300 feet in a meadow that is swampy in the middle -- a kind of basin -- looks good. Length along the creek is 2150 feet with a probability of being 100 feet more to a road that comes in there on the West or South-West.

At the 1400 foot cross section the width is 210 feet

"	1500	"	"	"	150	"
"	1800	"	"	"	100	"
"	2000	"	"	"	150	"
"	2150	"	"	"	100	"

The fence at 2150 divides from the Weaver property. Riddling piles all along the creek except at the swampy place which is probably underlaid with clay.

GRIER Property - Test Holes

Hole	Wet Lbs.	Dry Lbs.	Depth	Sand			Cr ₂ O ₃
				Ounces	Grains	Percent	
1	18.5	16.5	2.5	3.67		1.4	
2	21.5	17.5	3.5	8.54		3.05	
3	12.5	9.5	2.5	1.07		0.7	
4	22.5	16.5	2.0	4.72		1.79	
5	24.5	20.5	4.5	17.00	315	5.4	
6	21.5	19.5	6.0	11.00	90	3.6	
	Average		3.5			2.66	

Visited afternoon 7-12-18 #3 in upper swamp where I told John to dig in the first place. Hole shallow with clay too far from the edge of the trough made by the stream.
 150 x 150 = 322,500 sq. ft. x 3.5 = 1,128,750 cu. feet divided by 15 = 75,250 tons dirt.
 .66% of this amounts to 2,001.65 tons concentrates.

GRIFFINGS Property near Pilot, Maryland 6-29-18

Washing tests - self and R-

- Just below spring house not good sand or much of it. Good location geologically, that is, surrounded by serpentine with outcrop of honey-combed quartz.
- About 200 feet further down creek. Fine sand not unlike No. 1.
- At bend of creek near the end of the meadow.
- At what appears to have been the old tailing pile. Not much evidence of the sand having been worked to any great extent on this property. No 'riddlings' could be found to any extent.

WEST Property - Sand Chrome - Test Holes

Hole	Wet Lbs.	Dry Lbs.	Depth Feet	Grains	Percent	Cr ₂ O ₃
				Wt. Conct.		
1	10.5	7.5	2.5	2.160	2.0	
2	10.5	9.5	2.0	2.280	1.8	
3	11.5	9.5	2.5	3.220	2.3	
4	10.5	9.5	3.0	2.30	1.4	
5	12.5	9.5	2.0	2.140	1.5	
6	11.5	9.5	1.5	1.280	1.1	

WEST Property - Sand Chrome - Test Holes (continued)

Hole	Wet Lbs.	Dry Lbs.	Depth Feet	Grains Wt. Conct.	Percent	Cr ₂ O ₃
7	13.5	11.5	2.0	1.350	0.98	
8	14.5	11.5	1.5	1.320	0.97	
9	12.5	9.5	4.0	2.360	2.0	
10	12.5	10.5	1.0	2.210	1.6	
11	12.5	9.5	4.0	2.150	1.5	36.61%
12	11.5	9.5	3.5	4.20	2.7	39.53
13	13.5	7.5	2.5	4.200	3.7	40.70
14	10.5	8.5	1.5	4.230	3.3	37.74
15	14.5	12.5	3.0	4.250	2.3	40.58
16	10.5	9.5	1.0	3-110	2.14	40.42
17	11.5	11.5 Clay	4.0	4-100	2.3	43.07
18	12.5	10.5	2.0	4-300	2.8	37.36
19	13.5	10.5	3.0	4-350	2.8	38.64
20	15.5	12.5	3.5	1-260	0.8	40.62
21	15.5	11.5	2.0	2-225	1.3	39.10
22	13.5	10.5	2.0	2-370	1.7	36.94
23	11.5	9.5	5.00	2-70	1.4	43.75
24	12.5	9.5	4.0	2-190	1.6	36.98
25	11.5	8.5	1.0	1-130	0.9	
26	14.5	11.5	5.0	2-210	1.3	
27	12.5	9.5	4.5	3-130	2.2	
28	13.5	10.5	2.0	3-410	2.8	
29	13.5	10.5	2.5	2-260 ?		
30	10.5	6.5	4.0	1.76	1.7	41.38
31	15.5	9.5	1.5	2.6	1.71	40.12
32	19.0	13.5	4.0	2.12	1.24	32.06
33	17.5	15.5	1.0	5.44	2.15	44.28
34	15.5	13.5	2.0	5.48	2.53	37.48
35	13.0	11.5	5.0	5.38	2.91	37.66
36	15.5	13.5	4.0	3.33	1.54	36.24
37	13.5	11.5	2.0	0.77	0.42	34.80
38	14.5	13.5	4.0	3.15	1.46	42.80
39	20.0	16.5	6.0	3.96	1.5	43.90
40	20.0	16.5	3.0	14.7	5.57	35.86
41	19.5	15.5	4.0	3.35	1.35	36.14
42	17.5	11.5	1.0	11.44	6.21	39.54
43	18.5	15.5	3.0	9.24	3.72	43.86
44	14.5	11.5	4.0	1.16	0.72	42.44
45	19.5	14.5	2.0	7.7	3.31	40.66
46	16.5	12.5	2.0	4.6	2.3	40.72
47	17.5	13.5	3.0	5.74	2.65	42.84
48	18.5	15.5	2.0	10.52	4.24	39.35
49	15.5	13.5	2.5	2.8	1.3	42.44
50	17.5	13.5	2.0	2.97	1.4	41.53
51	17.5	10.5	1.5	9.4	5.6	37.60
52	17.5	11.5	3.0	2.52	1.37	41.78
53	17.5	13.5	2.0	4.11	1.9	40.84
54	18.5	15.5	4.0	5.75	2.31	44.60
55	21.5	15.5	4.0	9.75	3.93	42.92
56	19.5	15.5	3.0	9.2	3.7	42.92
57	21.5	17.5	3.5	10.7	3.6	
58	17.5	15.5	4.0	6.66	2.7	
59	16.5	13.5	4.0	3.25	1.5	
60	21.5	17.5	4.5	20.16	7.2	
61	13.5	11.5	3.0	4.3	2.33	
62	16.5	13.5	5.5	1.45	0.67	
63	15.5	13.5	6.0	6.47	2.31	
64	23.5	17.5	5.0	2.48	0.88	on bank
65	14.5	12.5	3.5	10.4	5.2	

WEST Property - Sand Chrome - Test Holes (continued)

Hole	Wet Lbs.	Dry Lbs.	Depth Feet	Grains Wt. Conct.	Percent	Cr ₂ O ₃
66	18.5	13.5	6.0	5.7	2.8	
67	20.5	14.5	2.0	8.47	3.65	
67a					2.75	
68	15.5	11.5	5.5	1.17	0.63	high on bank
69	24.5	18.5	3.5	6.01	2.03	
70	14.5	11.5	4.0	0.21	0.11	
71	19.5	15.5	5.0	24.15	9.73	
72	20.5	14.5	7.0	3.54	1.54	
73	19.5	16.5	6.0	3.73	1.40	
74	22.5	16.5	2.0	14.9	5.72	
75	21.5	15.5	6.0	8.43	3.4	
76	18.5	11.5	6.0	3.8	2.07	
77	21.5	18.5	4.0	8.85	3.0	
78	18.5	15.5	4.0	2.22	0.89	
79	20.5	17.5	3.5	8.96	3.2	
80	23.5	21.5	4.0	12.73	3.24	
81	21.5	14.5	4.0	0.97	0.42	

Number 72 - Top stratum - 0.57%

Middle Clay - 0.28

Bottom - 1.14

Average - 1.33

TRAINOR Farm - Owned by E. Kirk Brown of Elkton, Maryland.

In letter to John Hindman offers to sell farm of 200 acres for \$10,000 with \$4,000 down. There is probably a mortgage on it. Will give Hindman a commission of \$250. Is occupied by Brown's brother.

The farm is in a very run-down condition, buildings are in bad repair.

TRAINOR Farm - Rock Chrome- Serpentine & c

Crops out at about the 2500' cross section.

It is to be found frequently in the old riddling piles on the upper part of the property; but no where actually in place.

The serpentine does not actually appear until about the 2300' cross section.

From there to the Oxford road the rocks appear to be Gabbro Gneiss and considerable white quartz.

The qualit of the sand also runs off nearer the road, as might be expected.

TRAINOR Farm- Dimensions - 200 acres

From the Oxford road east to the first hole is 550 feet. Thence to the end of the property at the fence between it and the Algard farm is 2700 feet or a total of 3250 feet.

The width of the ore bearing land is hard to determine, as it is all rather flat.

Near the first hole the width is about 200 feet.

At hole number 3 it is about 150' whereas at hole 5 it is by actual measurement 450 feet. At the 2600 cross section it is 300 feet.

At the 3050' it is, or rather appears to be about 500 feet wide

" 2050' " about 200' wide

" 4000' " " 200' "

" 4250' " " 100' " This is at the end of the property

The channel on the Algard at this point is not over that width.

TRAINOR Farm - Test Holes

#	Wet Lbs.	Dry Lbs.	Depth	Ounces Weight Sand	Percent	Cr ₂ O ₃
1	22.5	15.5	6.0'	15.15	6.11	
2			4.0'	Nothing in the dirt		
3	17.5	13.5	4.0'	6.14	2.84	Composite
4	21.5	16.5	6.0'	4.046	1.6	sample
5	23.5	19.5	5.0'	33.125	10.9	from all ex
6	21.5	15.5	5.0'	3.062	1.23	cept 9 and
7	20.5	13.5	5.0'	3.09	1.43	10, gave
8	22.5	17.5	3.5'	6.562	2.34	32.48%
9	21.5	14.6	4.0'	16.01	7.3	per
10	22.5	14.5	3.5'	7.12	3.07	Davis
Average				10.478	4.09	7-24-18

Average for the first seven omitting #2 - 3.78

#9 and 10 are in the swamp opposite the rock pile where the ore bearing ground is 350' wide.

CULLUM Tract - Dimensions of ore bearing ground

This tract is in Elk Township, Chester County, Pennsylvania

General sample gave 44.26% Cr₂O₃ taken 6-19-18; assayed by Davis 6-13-18.

According to John Cain was worked by Mortimer Bye. There are old 'riddling piles' on both sides of the road as far as the streams run through the property. Contains 70 acres. The stream is the Little Elk Creek. On the east side of the road across the riddling piles is 200 to 250 feet. From the road to the Hansen line fence is 1150 feet.

From the road to the Grier boundary on the west following the stream is 500 feet; hence the property is 1650 feet long following the stream and the ore basin averages about 200 feet at the most and probably not over 150 should be counted on.

1650 x 150 = 247,500 sq. ft. x 3 = 742,500 cu. ft. divided by 15 gives 49,500 tons which at 247,500 square feet x 3.75 = 928,125 cubic feet which divided by 15 gives

The average depth of these holes is 3.75

" percent " 2.38

61,875 tons - 2.38% of this is 1,472,625 tons concentrates.

CULLUM Tract - Test Pits - John Cain began work on them 7-1-18

Hole	Wet Lbs.	Dry Lbs.	Depth feet	Ounces Weight con.	Percent	Cr ₂ O ₃
1	24.0	16.5	2.5	6-260 grs.	2.5	Composite
2	24.5	16.5	5.0	5-181 "	2.05	Sample
3	21.5	14.5	3.0	7-220 "	3.2	42.82%
4	18.5	14.5	4.0	8-40 "	3.5	(Davis)
5	17.5	14.5	3.5	3-400 "	1.6	7-13-18
6	17.5	14.5	4.5	3 1/4 "	1.4	

Number 6 was on the side of an old chrome hole and is in consequence a very unsatisfactory test.

Number 4 is wholly in clay.

Screen tests of this sand shows a considerable proportion coarser than 20 mesh.

Practically all the gangue went through 40 mesh leaving most of the good ore on the screen and splendid stuff it is. The 60 mesh had rather more quartz than the 80 which has the most gangue. The stuff which went through the 80 is nearly all quartz.



Figure 5. Vein of massive chromite at bottom of Wood mine. Photo taken February 1938.

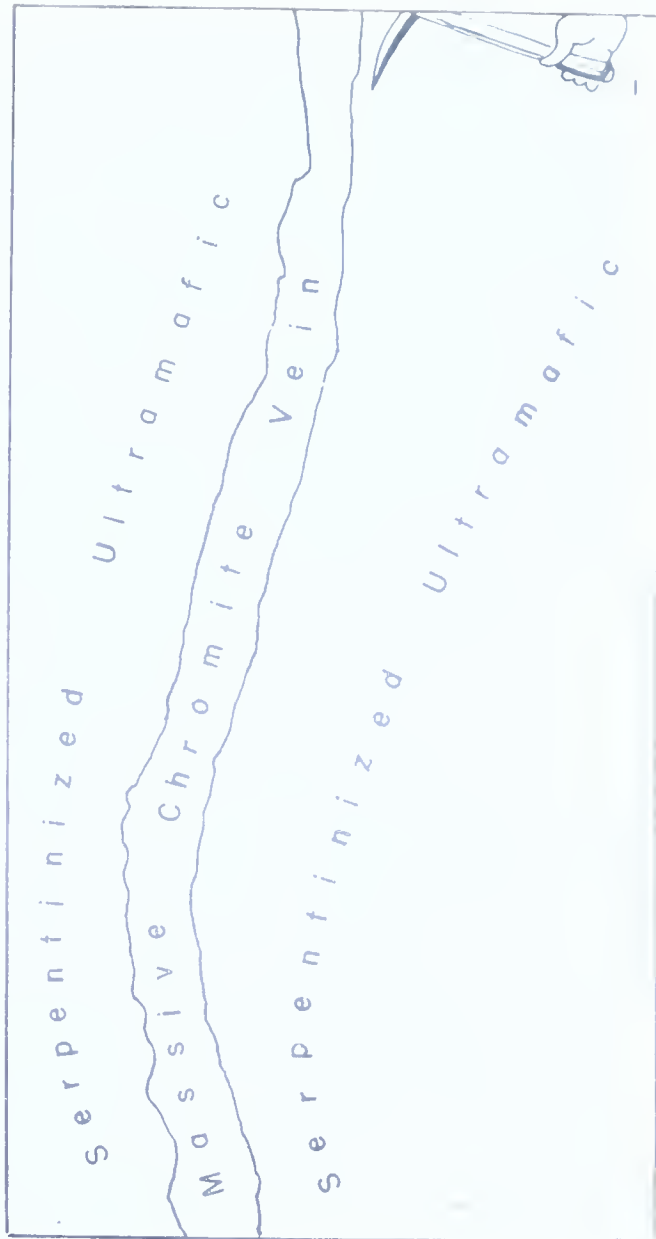


Figure 6. Sketch of contacts shown in Figure 5.

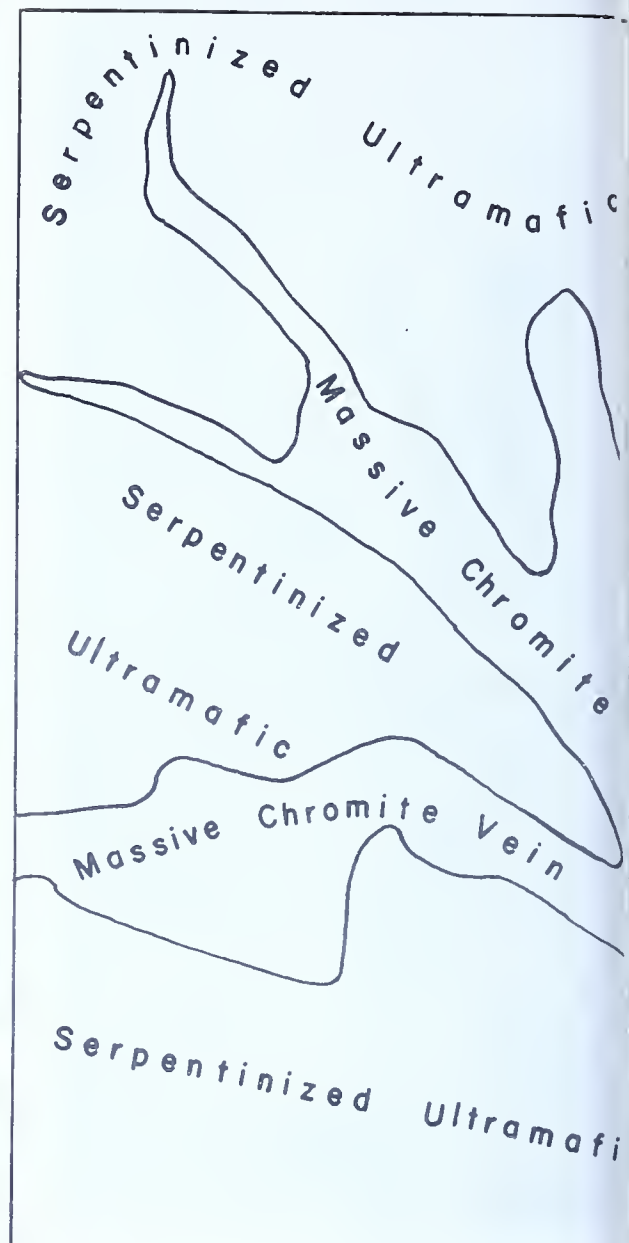


Figure 7. Vein of massive chromite in wall of Wood mine. Photo taken February 1938.

Figure 8. Sketch of contacts shown in Figure 7.

APPENDIX II

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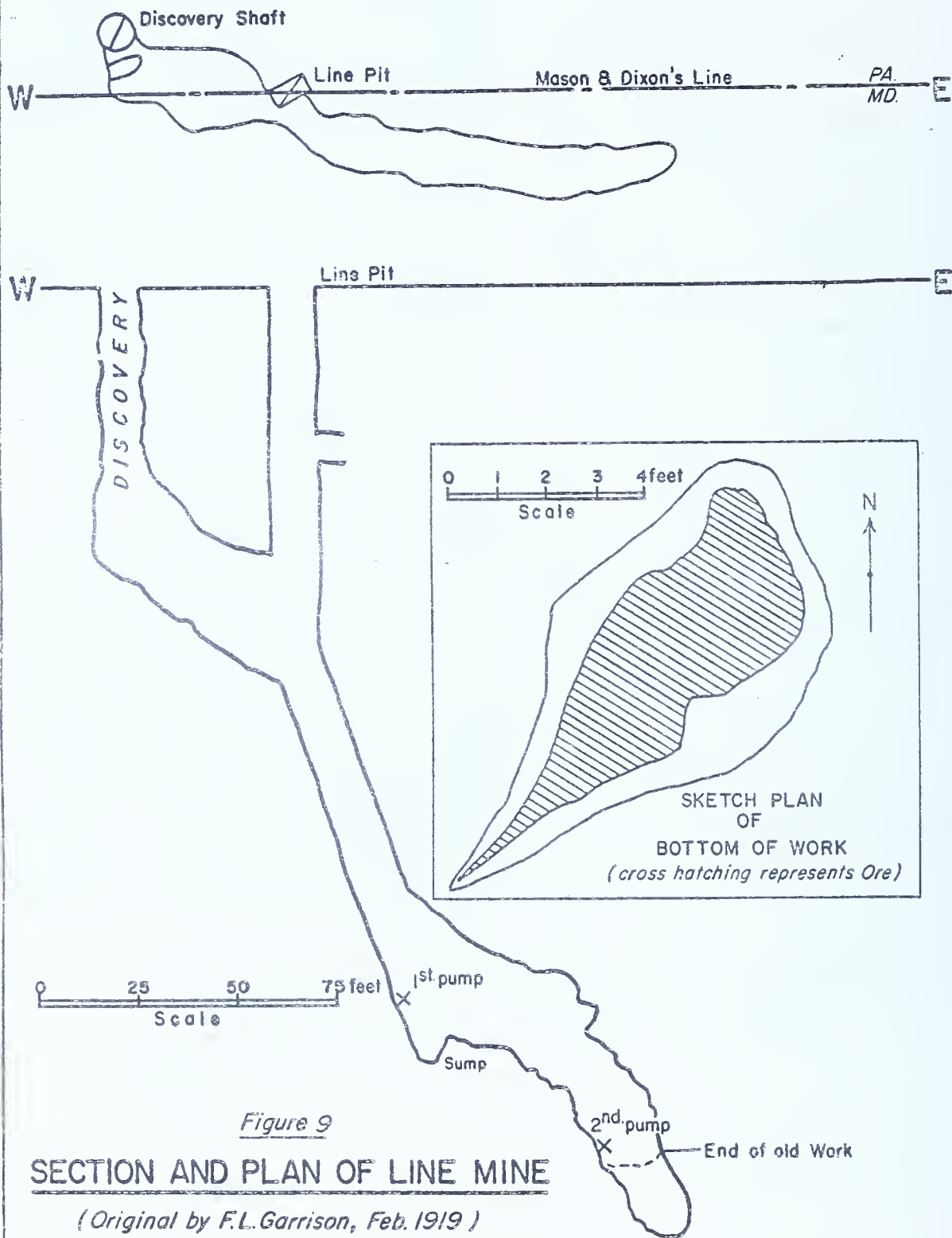


Figure 9

SECTION AND PLAN OF LINE MINE

(Original by F.L. Garrison, Feb. 1919)

